AIR FORCE

QUALIFICATION TRAINING PACKAGE (AFQTP)

for

ELECTRICAL POWER PRODUCTION

(3E0X2)

MODULE 23

POWER PRODUCTION ACCESSORY AND AUXILIARY EQUIPMENT

TABLE OF CONTENTS

MODULE 23

POWER PRODUCTION ACCESSORY AND AUXILIARY EQUIPMENT

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

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INTRODUCTION

Before starting this AFQTP, **refer to and read the "Trainee/Trainer Guide" located on the AFCESA Web site** http://www.afcesa.af.mil/

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location*.

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Career Field Manager at the address below.

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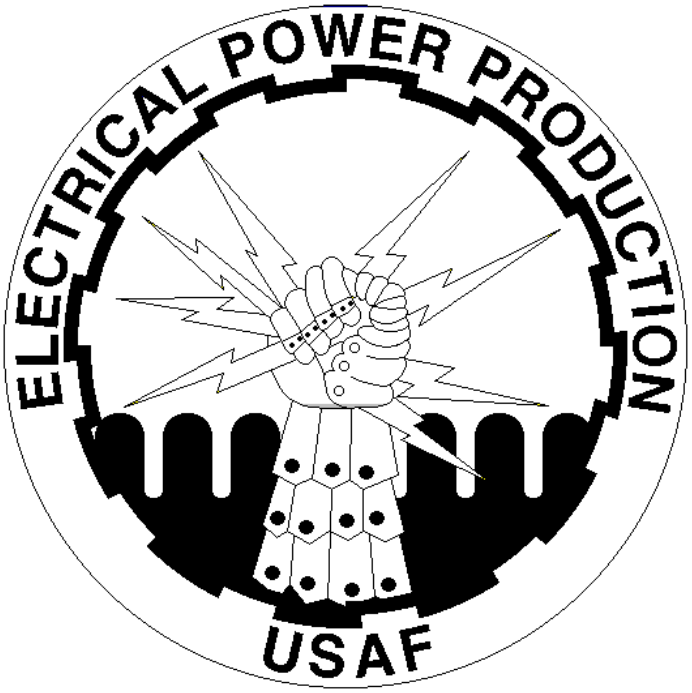

BATTERY CHARGERS

MODULE 23 **AFQTP UNIT 5**

INSPECT (23.5.1.)

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INSPECT

Task Training Guide

CFETP Reference Number:	23.5.1, Inspect
Training References:	• 35 series Technical Orders
Prerequisites	• Possess, as a minimum a, 3E032 AFSC
Equipment/Tools Required:	• Multimeter
Learning Objective:	• Determine type charger is being used, and inspection proceedures.
Samples of Behavior:	• Trainee should be able to successfully determine what type of charger you have in front of you and be able to tell you what to inspect on that particular charger. Trainee should also be able to answer 80% of review questions on battery chargers, successfully.
Notes:	
• Scoring less than 80% on test will require student to reaccomplish this entire AFQTP.	

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INSPECT

Background: An important part of the Power Production career field is being able to maintain the working integrity of the generator set and its related equipment. In order to keep the unit running in top-notch condition, a few minutes spent inspecting the battery chargers before each generator run could mean the difference between 100% power reliability, or answering why it didn't start.

SAFETY:
BEFORE WORKING ON THE BATTERY CHARGER, MAKE SURE ALL POWER IS ISOLATED FROM THE CHARGER TO INCLUDE: AC INPUT, AND DC GOING TO THE BATTERIES. THIS IS A POTENTIALLY DANGEROUS SOURCE OF ELECTRICITY, AND SHOULDN'T BE TAKEN LIGHTLY!

The main focus of a preventive maintenance inspection (PMI) is to keep a particular piece of equipment in good working order. We will discuss three major categories of battery chargers: stationary; engine-driven; and solar.

Stationary battery chargers are used for the sole purpose of keeping batteries at their peak amp-capacity. That is to say the batteries are kept fully charged for their next use, whether it be for starting an engine, powering a Uninterruptible Power System(UPS); or powering the controls on a generator (MEP-012, or air-start engines). Stationary battery chargers use an external AC power source as input power, typically 120VAC. The batter charger in-turn converts the input voltage to the required output DC voltage and DC amperage. The amperage is dictated by the desired charging rate.

NOTE:
Make sure the commercial power source and DC output of the charger are compatible with the equipment that you are dealing with. (ie.-120 VAC input/24 VDC output)/(480 VAC input/12 VDC output)

Chargers usually have several different charging rates which may be selected manually or automatically. Paying close attention to what rate the batteries are being charged will prevent possible damage to the batteries, an example, if the batteries are overcharged, it will cause the cells to dry and damage the battery. On gel-cell batteries, it will cause the side to expand and possible explode.. The only time a charger should read anything over two amps is upon initial engine start-up, after long periods of drain(cranking, etc.) or if on the "equalize" setting.

NOTE:
Stationary battery chargers usually only have a rate of charge adjustment, and don't have a voltage adjust rheostat, so they put out a constant current no matter what the battery voltage is!

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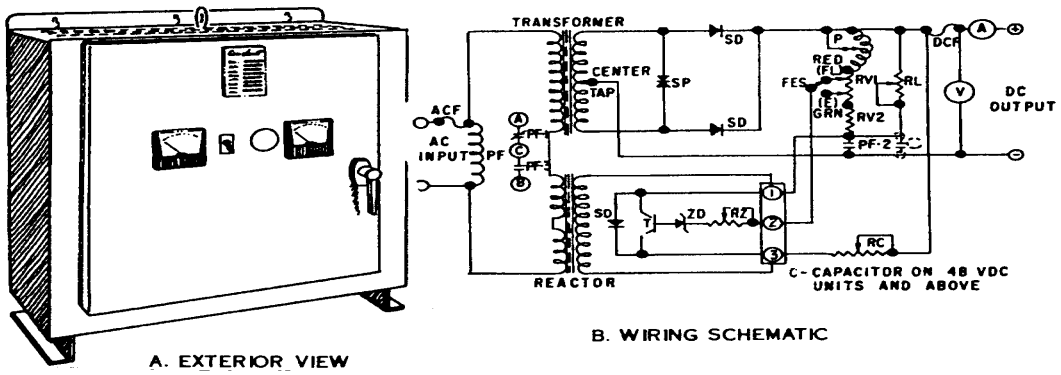
Some of the equipment and modes of the stationary battery chargers (Figure 1) that should be briefly explained are:

- **Voltmeter:** this meter indicates the output voltage of the battery charger
- **Ammeter:** amperage needed to charge the battery to a particular voltage
- **Float mode:** normal charging mode of the battery charger
- **Equalize mode:** higher level of charge used to eliminate any charge level differences among the individual cells of the batteries.

> **NOTE:**
> Make sure the commercial power source and DC output of the charger are compatible with the equipment that you are dealing with. [i.e.,.-(120 VAC input/24 VDC output)/(480 VAC input/12 VDC output)]

The items to be inspected during the PMI on these chargers are as follow:

- **Step 1:** Worn, frayed or otherwise defective input and output wiring.
- **Step 2:** Meters working and proper setting.
- **Step 3:** Lights and adjustment knobs functional.
- **Step 4:** Fuses for continuity and proper amperage rating .
- **Step 5:** All electrical connections are clean, free of corrosion, tight, and serviceable.
- **Step 6:** Enclosure is free of dust, dirt, corrosion, and moisture.
- **Step 7:** Mounted in an environmentally friendly site, free from direct sunlight, rain, insects, and other hazards that could affect the life of the charger and pose a threat to maintenance personnel.
- **Step 8:** Verify output after all other maintenance has been completed, and unit has been plugged in.



Self-contained battery charger and schematic.

Figure 1, Self Contained Battery Charger and Schematic

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Engine-driven battery chargers, are mounted on the prime mover to keep the start and control batteries at their peak amp-capacity. The engine-driven battery charger also serves to power the DC control circuits while the engine is running. This way, the batteries are not being constantly drained and charged at the same time, which would decrease their life expectancy tremendously! Instead of converting an external AC power source to DC, the engine-driven charger uses the exciter principle. The prime mover turns the rotor of the battery charger via a belt and pulley system. The movement of the rotor inside the stator creates an electric field. This DC electric field gets picked up by the brushes on the rotor commutator, and then charges the batteries and powers the control circuits. The inspection criteria for the engine-driven battery chargers (Figure 2) are basically the same as the stationary chargers.

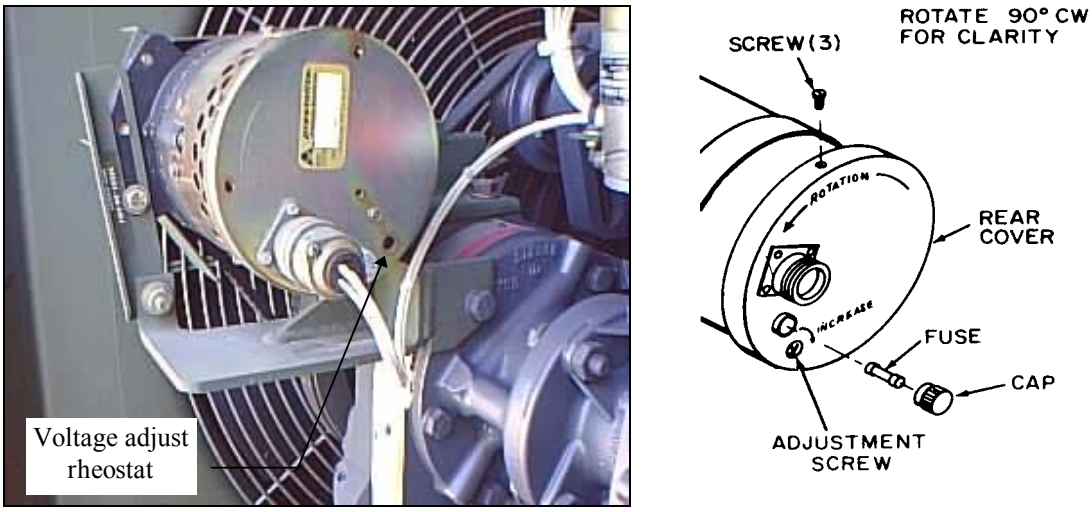

Figure 2, Engine Driven Battery Charger

When inspecting the engine-driven battery charger, inspect for the following:

- **Step 1:** Worn, frayed or otherwise defective input and output wiring.
- **Step 2:** Meters properly set and operational.
- **Step 3:** Fuses for continuity and proper amperage rating
- **Step 4:** All electrical connections are clean, free of corrosion, tight, and serviceable.
- **Step 5:** Enclosure is free of dust, dirt, corrosion and moisture.
- **Step 6:** Belt tension set to 1/2" deflection.
- **Step 7:** Belt sheave (pulley) properly installed and free of nicks, burrs, and dents.
- **Step 8:** Perform a functional check.

NOTE:
There are some irregularities that may be observed when viewing the ammeter and voltmeter of the battery charger that you may try to adjust, and they will be discussed in AFQTP 23.5.2.

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Solar-Powered battery charger (Figure 3) is one of the latest forms of battery chargers batteries. They were developed to keep the batteries at their peak amp-capacity by utilizing the light from the sun to charge the batteries. The sunlight will cause the molecules of the solar panel to excite, creating an electric field used for charging. Usually the size of the solar panel dictates the amount of amperage that can charge a battery. The charge for a typical charger will vary from 50 to 500 milliamps, depending on its size, and the intensity of the sun. The more sophisticated chargers will have a commercial backup source for night-time charging, and a desulfator to keep charging bi-products from "choking" the battery, and keeping the batteries as charged as possible.

Figure 3, Solar Powered Battery Charger

SAFETY:

BEFORE WORKING ON THE BATTERY CHARGER, MAKE SURE THAT ALL POWER IS ISOLATED FROM THE CHARGER TO INCLUDE: SOLAR PANEL HAS TO BE FULLY DARKENED, AND THE DC GOING TO THE BATTERIES NEEDS TO BE DISCONNECTED TO PREVENT BACK-FEEDING. THIS IS A POTENTIALLY DANGEROUS SOURCE OF ELECTRICITY, AND YOU SHOULDN'T TAKE IT LIGHTLY!

As with the previous battery chargers, inspections have to be performed on a regular basis. There are only a few items that should be examined when inspecting a solar charger, and they are as follow:

- **Step 1:** Worn, frayed or otherwise defective input and output wiring.
- **Step 2:** Corrosion and cleanliness of the solar panel and monitor group.
- **Step 3:** All electrical connections are clean, tight, and serviceable.
- **Step 4:** Verify the output of the charger after correctly reinstalling unit on battery.

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Review Questions
for
Inspect

Question	Answer
1. What is the power source for the solar battery charger?	a. AC commercial power b. desulfator c. engine d. sunlight
2. Which type of battery charger is used with UPS systems?	a. solar b. stationary c. engine-driven d. portable
3. What is the power source for the stationary battery chargers?	a. AC commercial power b. desulfator c. engine d. sunlight
4. During an inspection, you discover the batteries are dry, what could be the possible cause?	a. Broken battery charger b. Low charging rate c. High charging rate d. Battery charger is off
5. What do you check when inspecting an engine driven battery charger drive belt?	a. Belt tension set to 1/2" deflection. b. Belt sheaves (pulley) properly installed and free of nicks, burrs, and dents. c. Belt tension d. All the above

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INSPECT

Performance Checklist		
Step	**Yes**	**No**
1. Identify different types of battery chargers		
2. Battery charger operation		
3. Inspect a stationary and engine driven battery charger		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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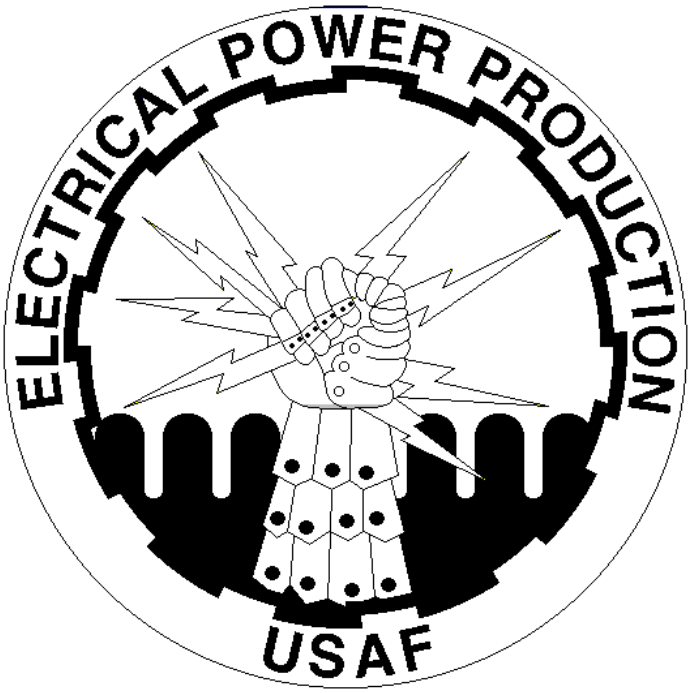

BATTERY CHARGERS

MODULE 23 **AFQTP UNIT 5**

ADJUST (23.5.2.)

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ADJUST

Task Training Guide

CFETP Reference Number:	23.5.2., Adjust
Training References:	d. 35C2 series Technical Orders
Prerequisites	e. Possess as a minimum a 3E032 AFSC
Equipment/Tools Required:	f. Multimeter
Learning Objective:	g. Adjust on a battery charger to correctly charge a battery.
Samples of Behavior:	h. Successfully identify and describe the adjustment controls of a battery charger. Trainee should also be able to answer 80% of review questions on battery chargers, successfully.
Notes:	
i. Scoring less than 80% on test will require student to reaccomplish this entire AFQTP.	

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ADJUST

Background: As with any other piece of equipment, battery chargers need to be adjusted, just as you adjust the valves of an engine during a schedule maintenance inspection or when they start to tick. Preventive Maintenance Inspections is to prevent disasters from ever happening in the first place! As discussed in AFQTP 23.5.1(Inspect), there are essentially three different types of battery chargers. As with anything else, these chargers all have something in common, but they also have their differences. We'll discuss each one, and what can be adjusted to compensate for irregularities.

SAFETY:
IT'S IMPERATIVE THAT YOU USE EXTREME CAUTION WHEN WORKING WITH BATTERIES AND CHARGERS, BECAUSE EXPLOSIVE GASES EMANATING FROM THE BATTERIES, MIXED WITH SPARKS, MAKE AN EXPLOSION! OVERCHARGING OF A BATTERY MAY ALSO CAUSE THE BATTERY TO EXPAND AND EXPLODE, SO BE CAREFUL!

Stationary battery chargers usually have some sort of adjustment device on them, but for the most part only regulate the rate of current draw. The following are a few examples of stationary battery chargers and what adjustments they require:

Some of these chargers feature a few select tap settings on the step-down transformer where you would physically move a wire from one setting to another for a "HI", "MEDIUM", or a "LOW rate of charge. See figure 1 below.

SAFETY:
BEFORE WORKING ON THE BATTERY CHARGER, MAKE SURE THAT ALL POWER IS ISOLATED FROM THE CHARGER, INCLUDING THE AC SOURCE AND THE BATTERIES.

Figure 1, Select Tap Charger

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Figure 2, Dial Charger

Some of the other chargers feature a "dial" in which you can select the raw battery voltage setting (12, 24, 36VDC), and a fixed charging rate. Obviously, the problem with these chargers is that they will continue to charge at that rate until: the charger is manually turned off, a timer turns it off, or a fuse blows from the battery voltage getting too high from overcharging. See figure 2 above. These types of charger typically consist of the following items:

- **Float mode:** The normal rate of charge.
- **Equalize mode:** Higher rate of charge used to eliminate any charge level differences among the individual cells of the batteries. ($\leq$ 24 hours)
- **Timer:** Dial used to quantify the amount of charge time ($\leq$ 24 hours)
- **Fuses:** Circuit protection devices used to prevent overcharging

The **automatic battery charger** (Fig. 3) is the most common type of stationary battery charger you will come in contact with. This type of charger has a peak voltage setting for each particular raw voltage setting selected (12, 24, 36). When the charger has reached this particular peak voltage setting, it than goes into a "trickle" charge mode to maintain the battery at their peak voltage. This is an ideal charger for charging batteries, but is usually hampered by only one raw voltage setting, and long term use at fixed generator sites have proven less than effective by undo cycling of the charger's solid state voltage regulator. Also, when the battery develops a bad cell, the charger tries to compensate by charging even higher to equalize the cells. This unfortunately leads to boiling out of batteries and a quick kill and for any other batteries in the same charging circuit. Power spikes usually adversely affect the solid state voltage regulator board, with adequate spike protection, these chargers would be ideal.

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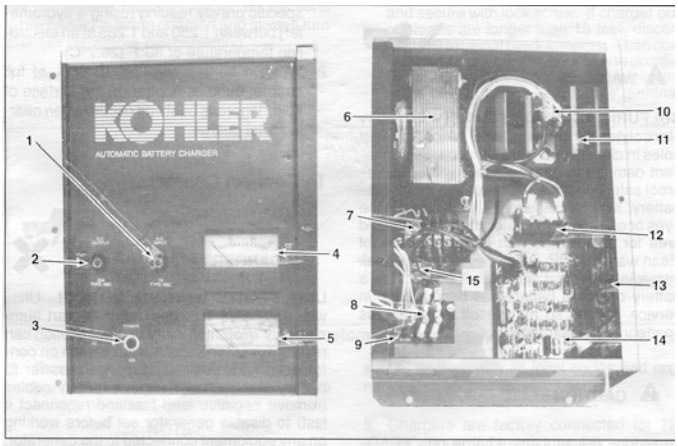
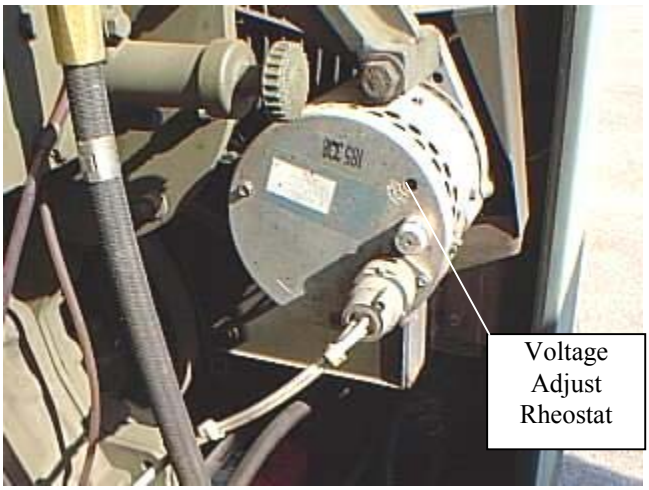


Figure 1. Battery Charger Components

1. AC Input Fuse
2. DC Output Fuse
3. "Power On" Lamp
4. DC Ammeter
5. DC Voltmeter
6. Transformer
7. AC Terminal Block
8. DC Terminal Block
9. Battery Sensing Connections
10. SCR Module
11. Heat Sink
12. Power Resistor
13. Alarm Circuit Board
14. Main Circuit Board Assembly
15. Ground Terminal

Figure 3, Automatic Battery Charger

Engine-driven battery chargers (Figure 4), are commonly referred to as battery charging alternators, serve the function of recharging the start batteries, and to power all DC control circuits while the engine is operating. Most of these chargers have a fixed voltage setting, internally set in the voltage regulator. This setting may, for the most part, be quite adequate for an automobile, or home use, but the MEP-00 generator sets, has an added feature that allows you to adjust the voltage setting for different charging rates, and battery types.



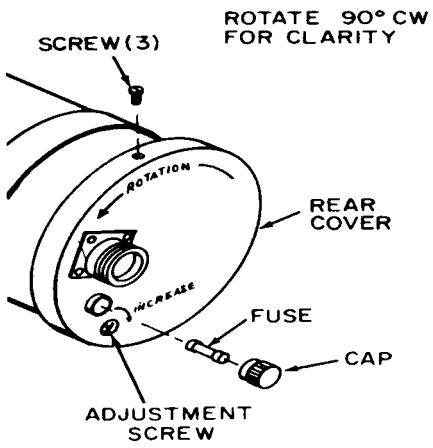


Figure 4, Engine-Driven Battery Charger

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The adjustment of the MEP-00 series alternators is as easy as turning a screw!

Step 1: Perform a pre-operational check on the generator set.

Step 2: Remove the cannon plug located on the back of the battery charging alternator.

Step 3: Start engine, and run at rated speed.

Step 4: Insert led from the multi-meter into the rear of the alternator receptacle (Pos. into terminal B, and Neg. into terminal C)

Step 5: Set adjustment screw (fig. 4) at the rear of the alternator for a reading of 24 +/- 2 volt DC. A clockwise rotation of the adjusting screw increases alternator output, counterclockwise rotation decreases output. If proper voltage is not obtained, shutdown engine and check alternator belt deflection.

NOTE:
Place the appropriate pin ends in between the rubber and the female socket plug to keep from holding the leads while you adjust the charger.

Step 7:. Reconfigure generator set to it normal configuration and document action taken.

Figure 5, Solar Powered Unit

The last battery charger that we are going to touch on is the **solar-powered unit** (Figure 5). These are usually bought for a specific generator site, as they have only one raw voltage setting (12, 24) and a fixed charging rate. These units are specifically used as trickle chargers, and are capable the same type of as the preceding chargers however, at a much lower charging rate. It would take a solar charger nearly a day to charge a 12 VDC battery, compared to a stationary charger, which would only take a few hours! The stationary charger is probably charging at a rate of 2 to 5 amps, while the solar is using 50 to 500 milli-amps. The trade off is longer life

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expectancy of the battery with a trickle charger. Again, the solar chargers are bought for specific sites with specific charging criteria, as they have no regulators.

NOTE:
The final word is that if you keep your chargers properly set, expect to increase the life expectancy of the batteries, and should show a decrease in stand-by calls due to battery failure.

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Review Questions
for
Adjust

Question	Answer
1. What adjustment can you make on the solar battery charger?	a. voltage b. current c. timer d. none
2. What battery charger has the potential to overcharge a battery to the point that it may explode?	a. solar b. stationary c. engine-driven d. portable
3. What stationary battery charger is plagued by an over-compensation in charging due to a low voltage condition?	a. select tap b. portable c. automatic d. solar
4. Which types of chargers are designed to utilize an alternative source of power besides AC ?	a. stationary, solar b. solar, engine-driven c. engine driven, portable d. portable, solar
5. Which charger utilizes a timer dial to regulate the time that a battery is charged?	a. solar b. stationary c. engine-driven d. portable

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ADJUST

Performance Checklist		
Step	**Yes**	**No**
Did trainee:		
1. Identify the different types of chargers		
2. Demonstrate knowledge of charger operation		
3. Inspect battery chargers		
4. Identify adjustments		
3. Adjust a battery charger		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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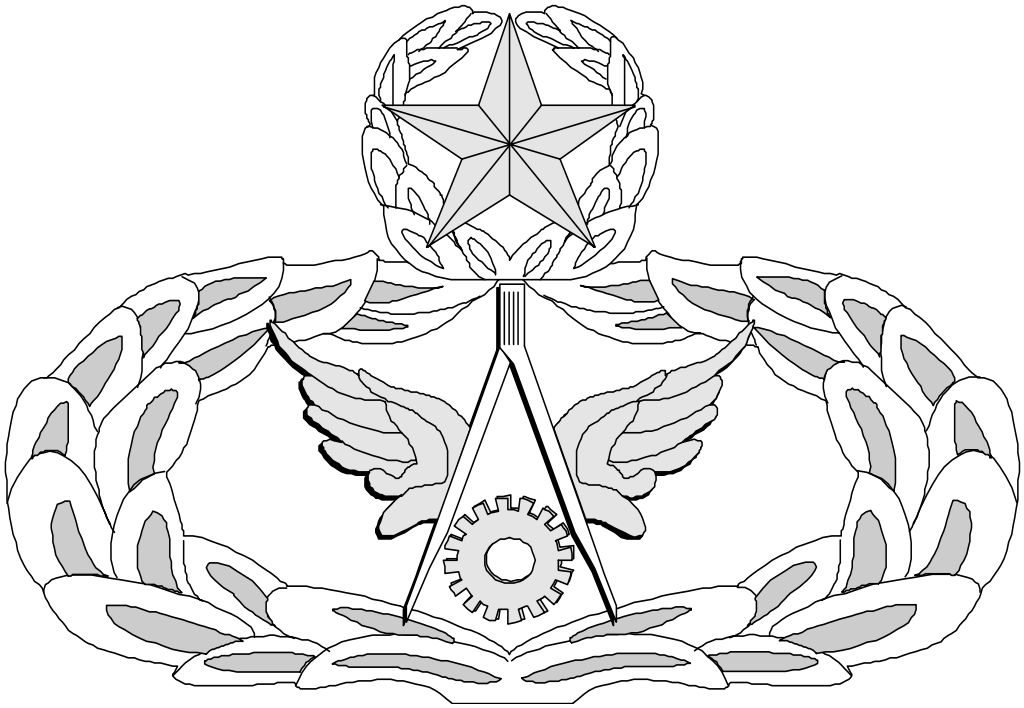
Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

ANSWER KEY



For

POWER PRODUCTION

(3E0X2)

MODULE 23

ACCESSORY AND AUXILARY EQUIPMENT

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INSPECT

(3E0X2-23.5.1.)

Question	Answer
1. What is the power source for the solar battery charger?	d. sunlight
2. Which type of battery charger is used with UPS systems?	b. stationary
3. What is the power source for the stationary battery chargers?	a. AC commercial power
4. During an inspection, you discover the batteries are dry, what could be the possible cause?	c. High charging rate
5. What do you check when inspecting an engine driven battery charger drive belt?	d. All the above

ADJUST

(3E0X2-23.5.2)

Question	Answer
1. What adjustment can you make on the solar battery charger?	d. none
2. What battery charger has the potential to overcharge a battery to the point that it may explode?	b. stationary
3. What stationary battery charger is plagued by an over-compensation in charging due to a low voltage condition?	c. automatic
4. Which types of chargers are designed to utilize an alternative source of power besides AC ?	b. solar, engine-driven
5. Which charger utilizes a timer dial to regulate the time that a battery is charged?	b. stationary

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